

# **Japanese Encephalitis (JE)**

*Disease burden & Cost-effectiveness  
of JE Immunization*

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# **Part I. JE endemic areas identified in the last 5 years**



# Why reported number of JE cases was low in tropical Asian countries (Indonesia, Malaysia, Philippines)?

- *Culex tritaeniorhynchus* laying eggs in rice fields is a Major mosquito vector; pig is an amplifying host.
- Rice cultivation and pig rearing are popular in most areas endemic for JE.
- Is tropical Asia ecologically favorable for JE transmission?
- Is JE risk low in Asian Muslim populations who do not rear pigs ( Indonesia, Malaysia)?

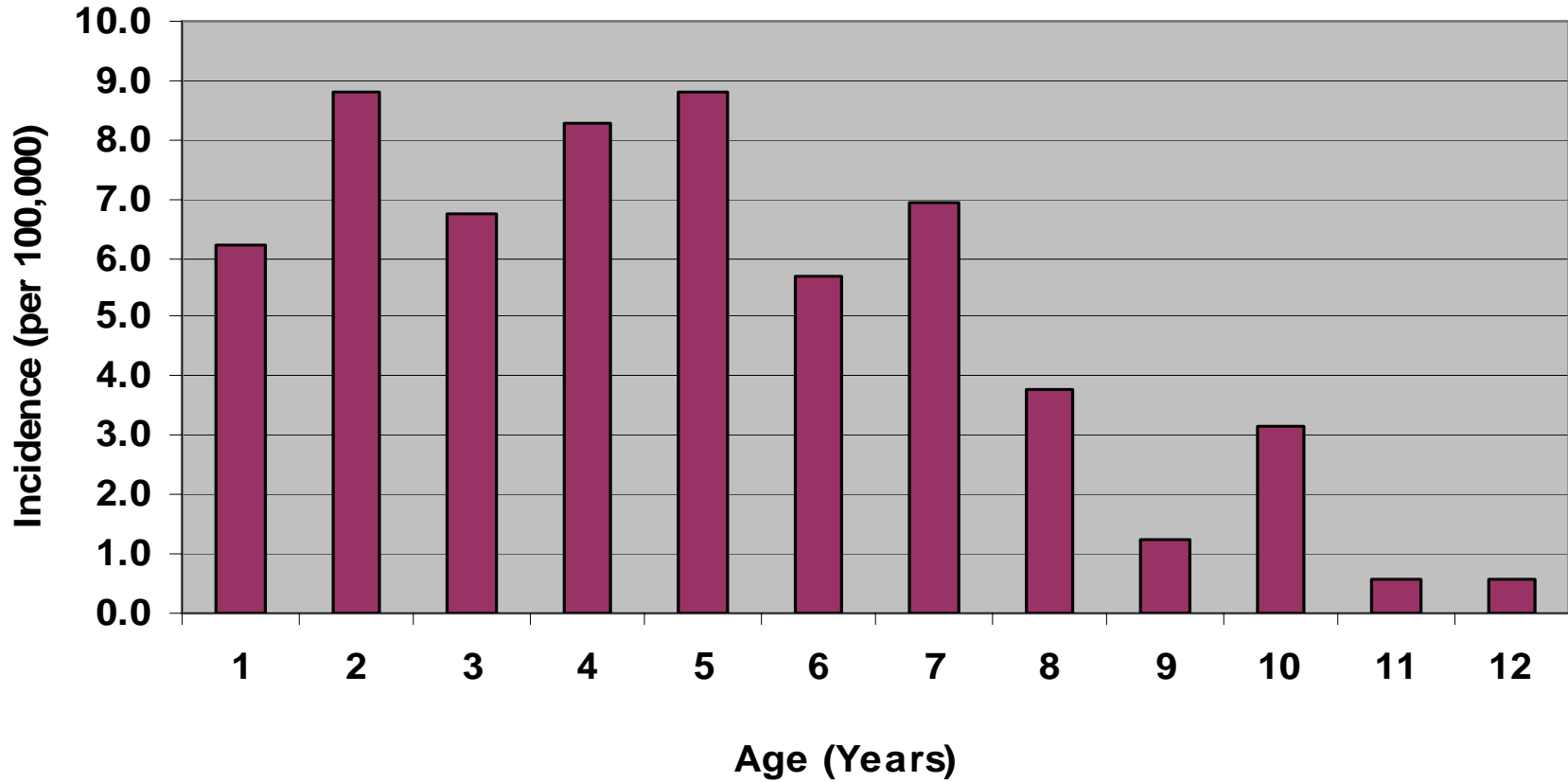
# We selected Bali, a tropical island, for JE surveillance

- >90% of Balinese are non-Muslim (Hindu).
- Piggeries and rice fields are popular.
- Health care is accessible and affordable.
- Catchment population is well defined; few people goes out of the island for care.
- All hospitals with inpatient service on the island were included for JE surveillance.
- All 600,000 children <12 yrs. Were under surveillance for 30 months.

# **Results of JE surveillance in Bali, Indonesia**

- JE appears to be hyperendemic in Bali, with high rates of incidence (8/100,000 in kids < 10 years) case-fatality (10%) and neurological disability (37%) during the 3 consecutive yrs. These findings contradict the common wisdom that JE is rare near the equator.
- JE virus is transmitted year-round.
- Pig appears to be an amplifying host for JE in Bali
- JE immunization has been recommended for Bali.

**Age Specific JE Incidence among Children 0-12 Years in Bali,  
Indonesia, Population-based Surveillance, July 2001 to Dec. 2004**

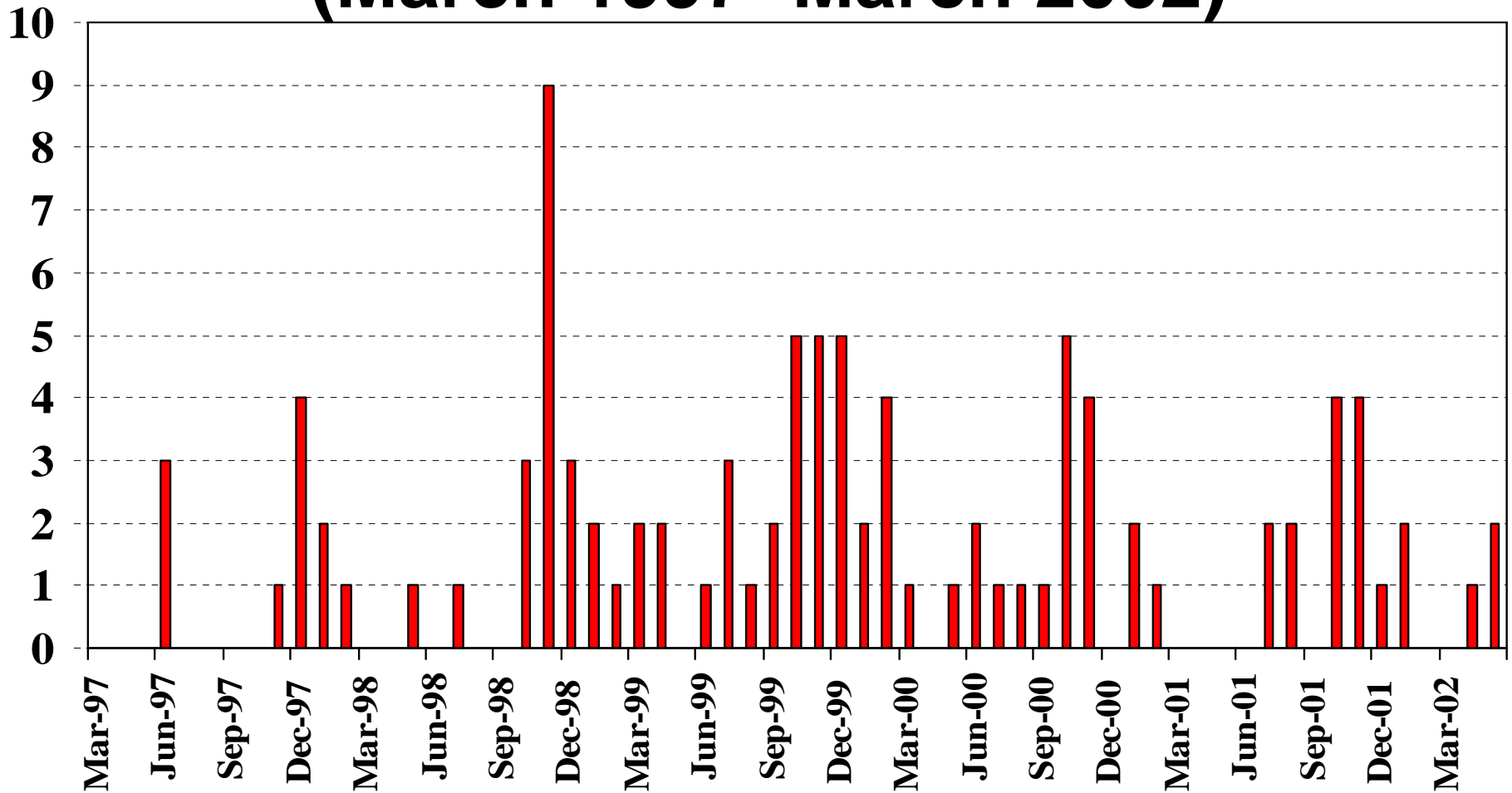


# High Risk of JE was found in another tropical country-- Cambodia

- *302 JE patients* were reported in Phnom-Penh 1996.
- Annual JE incidence rate was estimated at 5 per 100,000 children <10 years of age in Takeo province, 2000.
- *47 JE patients* were reported in Siem Reap, Cambodia, 2005.



# JE outbreak was reported in Sibul Hospital, Malaysia (March 1997- March 2002)



\* Cardoso, et al. 2002

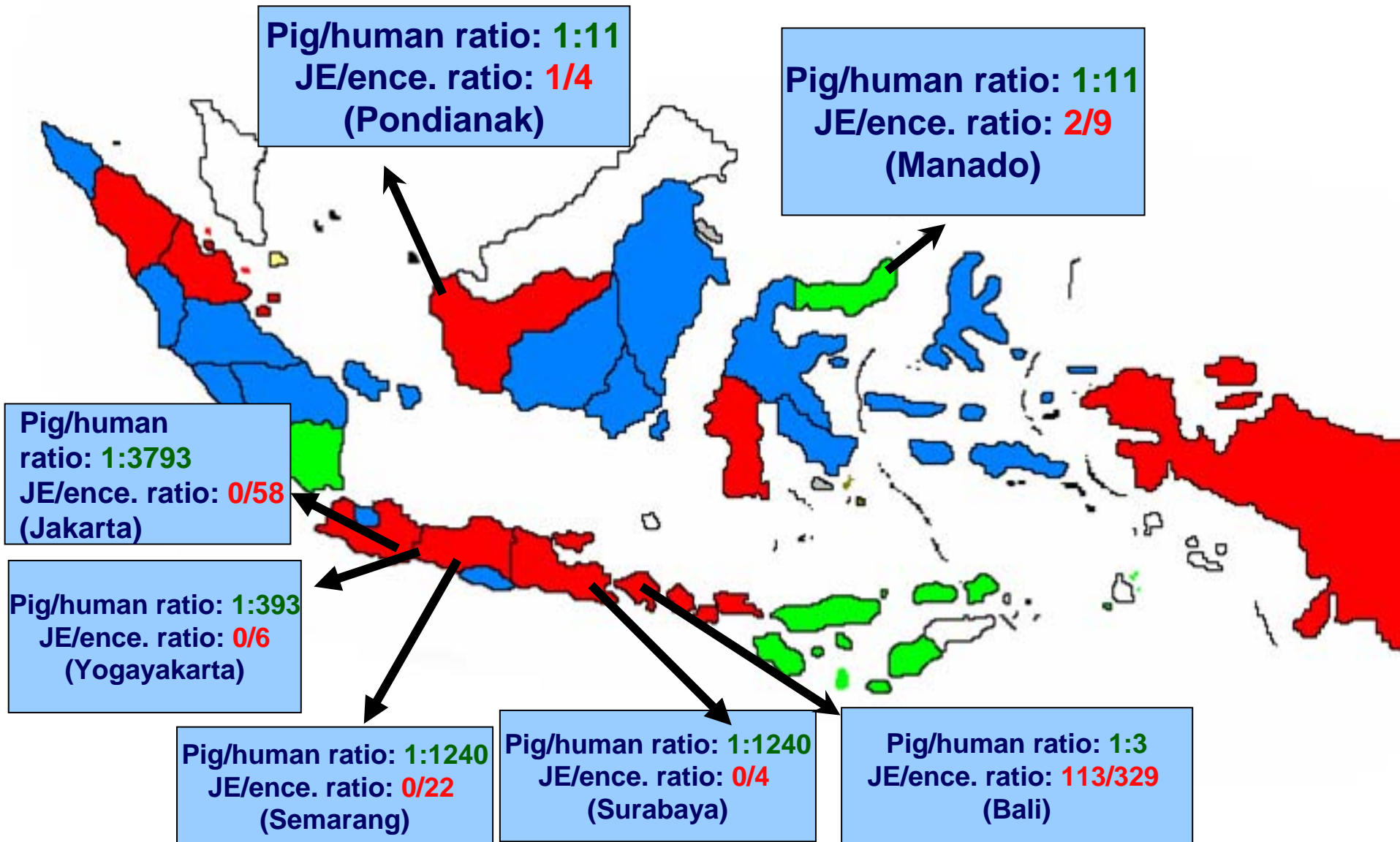
# **Tropical Asia is thus ecologically favorable for JE transmission**

- The allegedly low JE risk reported in tropical Asian countries (Indonesia, Malaysia, Cambodia and others) was due to insufficient surveillance.
- JE endemic areas have now been identified in Bali (Indonesia), Sibu (Malaysia), and Phnom Penh (Cambodia).

# JE in other parts of Indonesia

- Balinese are of Hindu ethnic and is unrepresentative of Indonesia where 90% population are Muslim.
- In Java (Muslim area), where 60% of Indonesian population reside, pig rearing is uncommon
- Is JE risk low in Java?

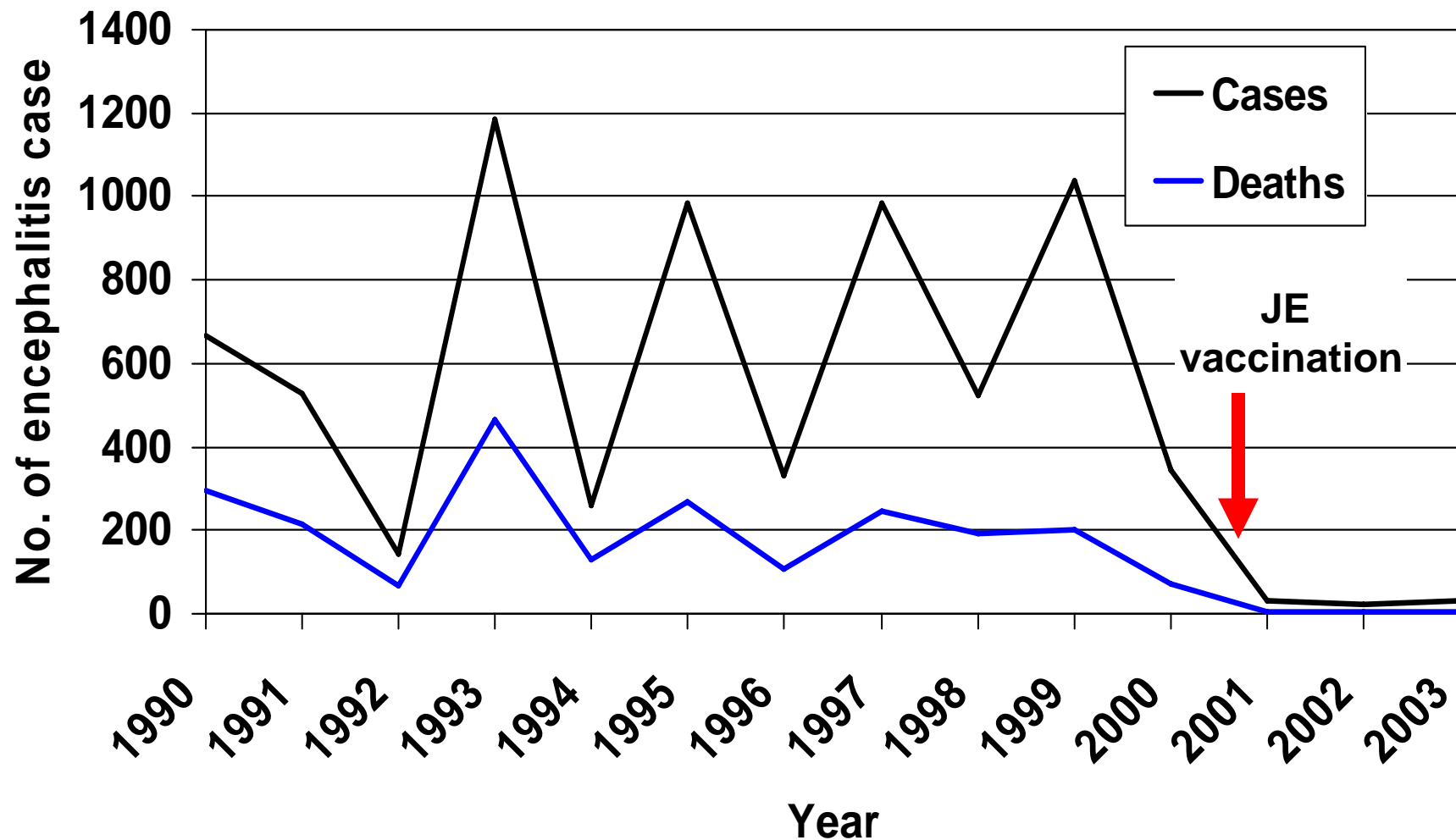
# JE cases and pig to human ratio, Indonesia



# Role of pig in transmission of JE

- In the 6 study sites of Indonesia, JE risk is low in all 3 Muslim populations with low pig/human ratio; it is high in all 3 non-Muslim populations with high pig/human ratio. Pig is a major host of JEV in Indonesia.
- Pig is not the only or necessary source of JE infection; JE cyclic epidemics were observed in Andhra Pradesh, India where pig was few.

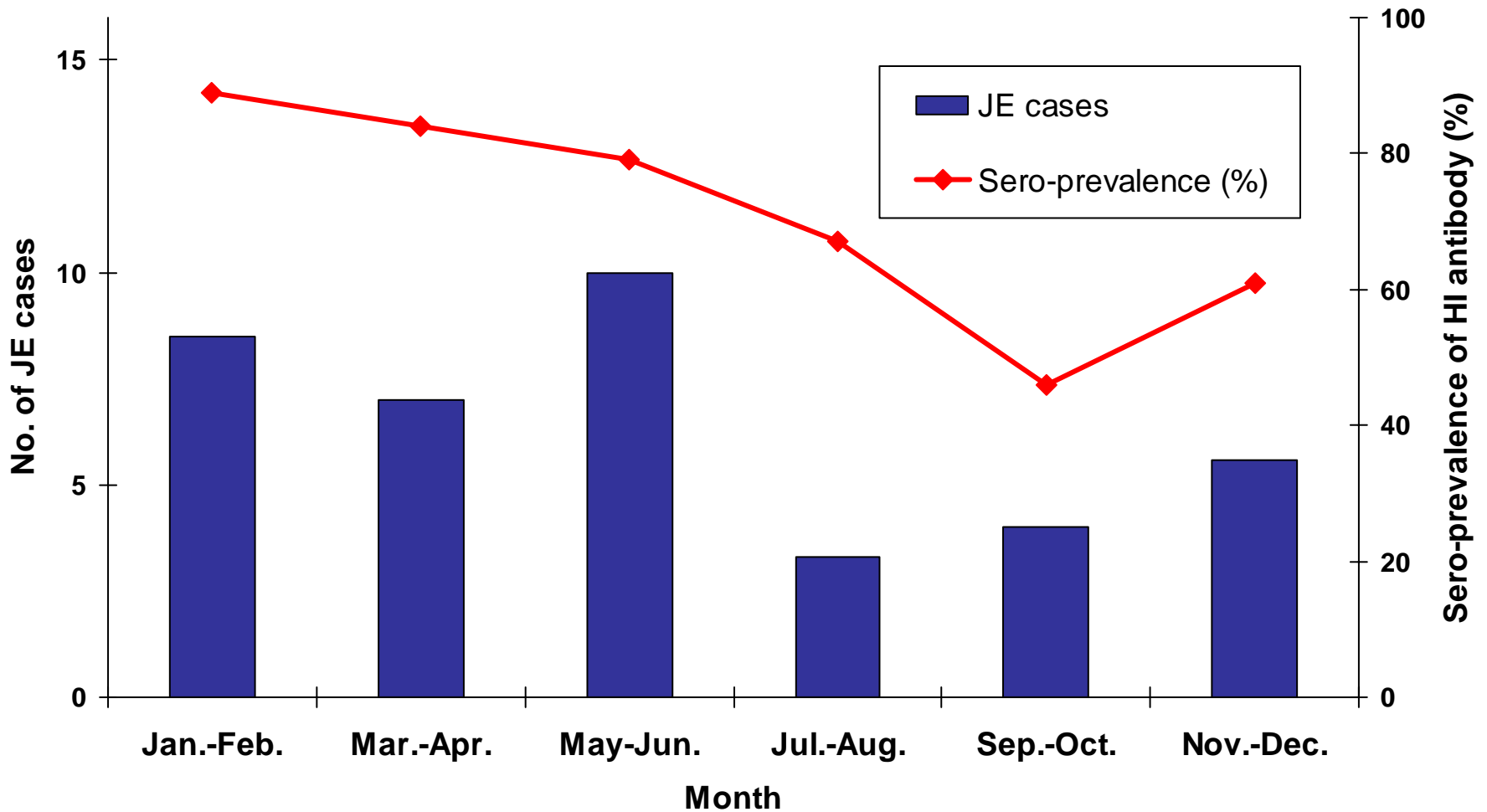
# JE in Andhra Pradesh, India



# Seasonal peaks of JE in different regions of Asia

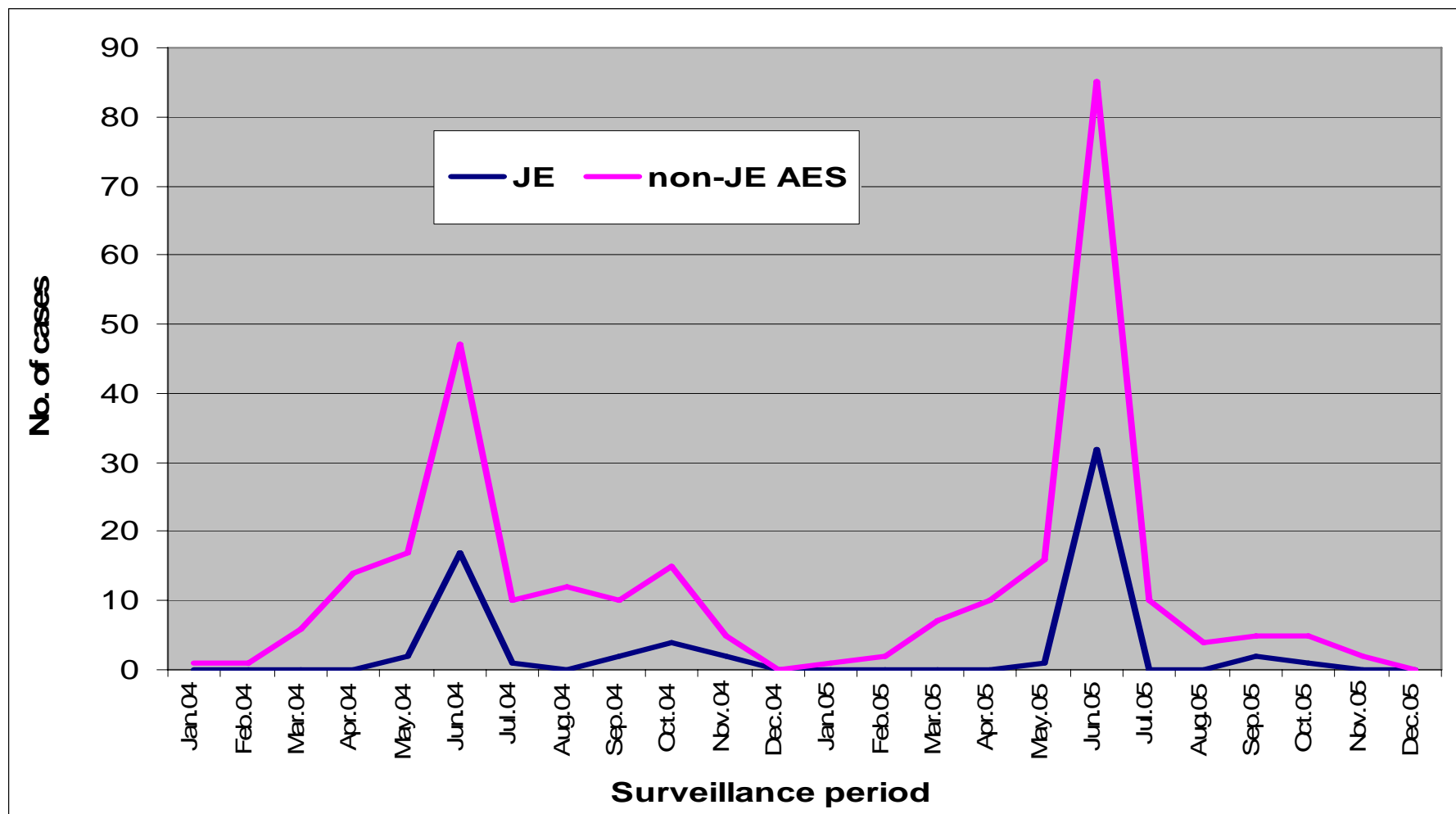
- JE virus is transmitted year-round without a sharp seasonal peak in the tropical countries (Bali).
- In the subtropical countries (Vietnam), JE is transmitted in around 8 months and no case was reported in the winter.
- In the temperate region, JE cases can be found in only 1-3 months of the year.

# Sero-prevalence of HI anti-JEV in pigs and JE cases, Bali, Indonesia

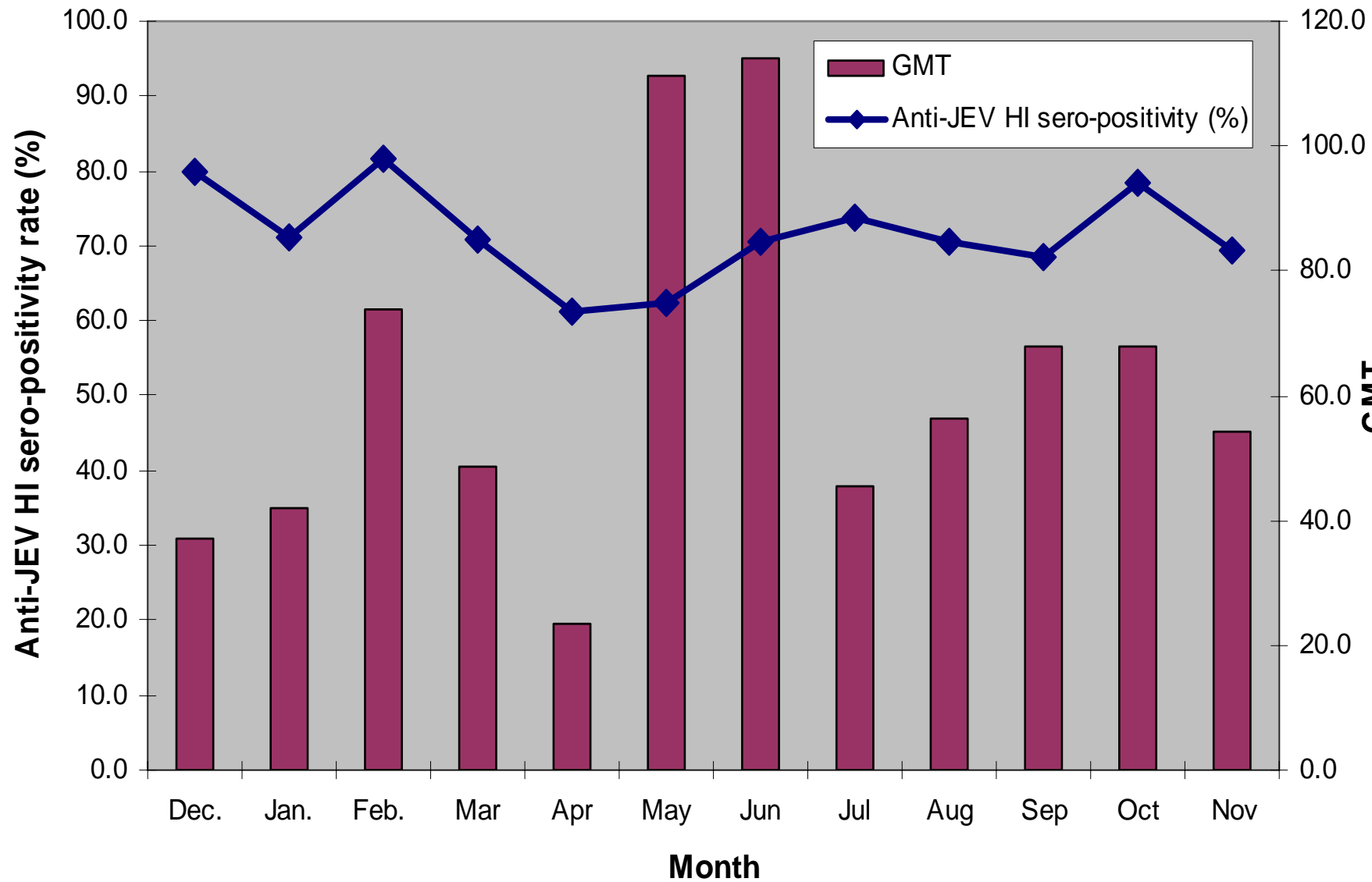


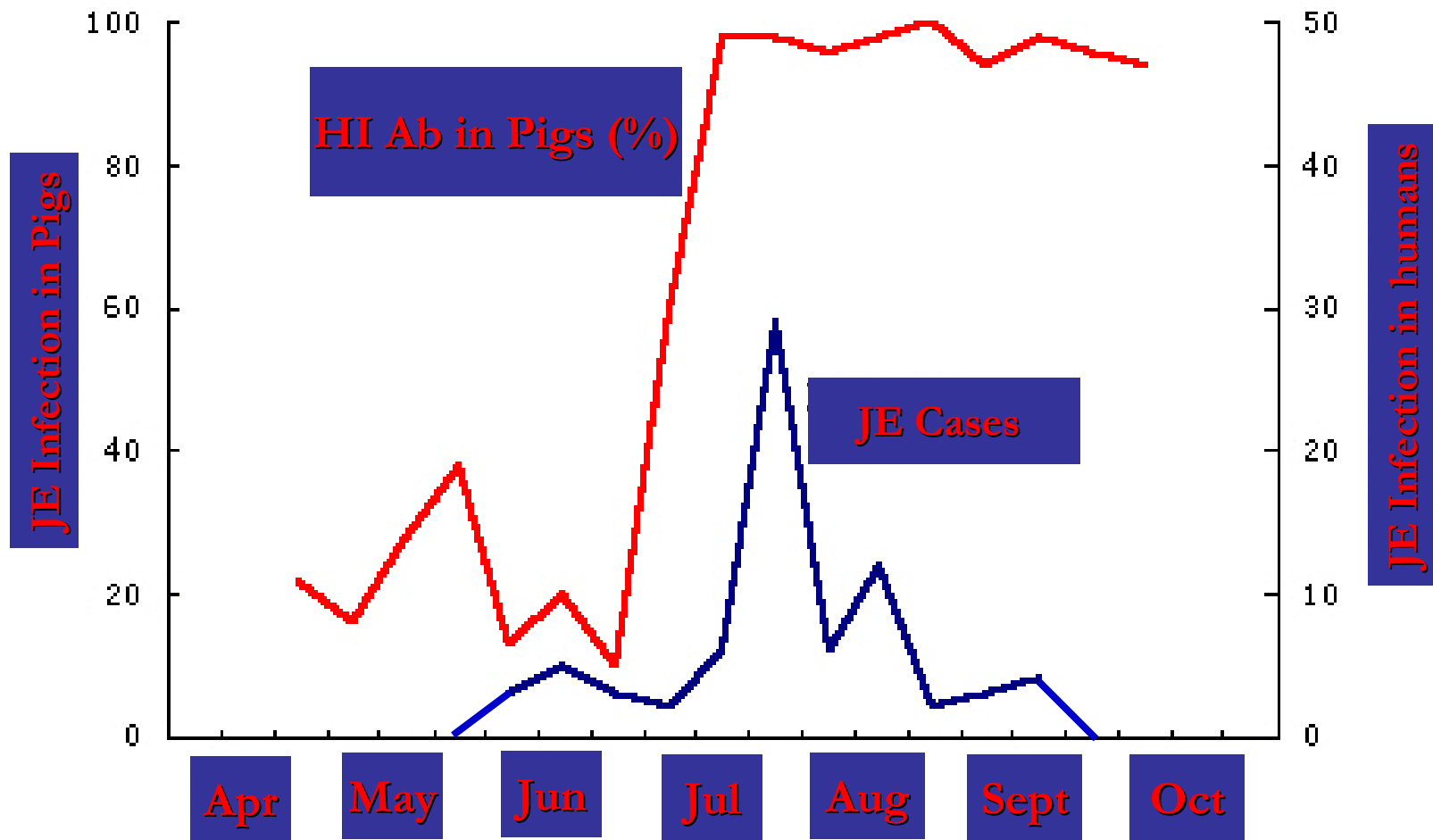


# Distribution of JE cases by month, Vietnam, a subtropical country



# JE infections in pigs in a Northern Vietnam province, December 1993- November 1994





Japanese encephalitis infection in pigs and humans, China

# Conclusions - Part I

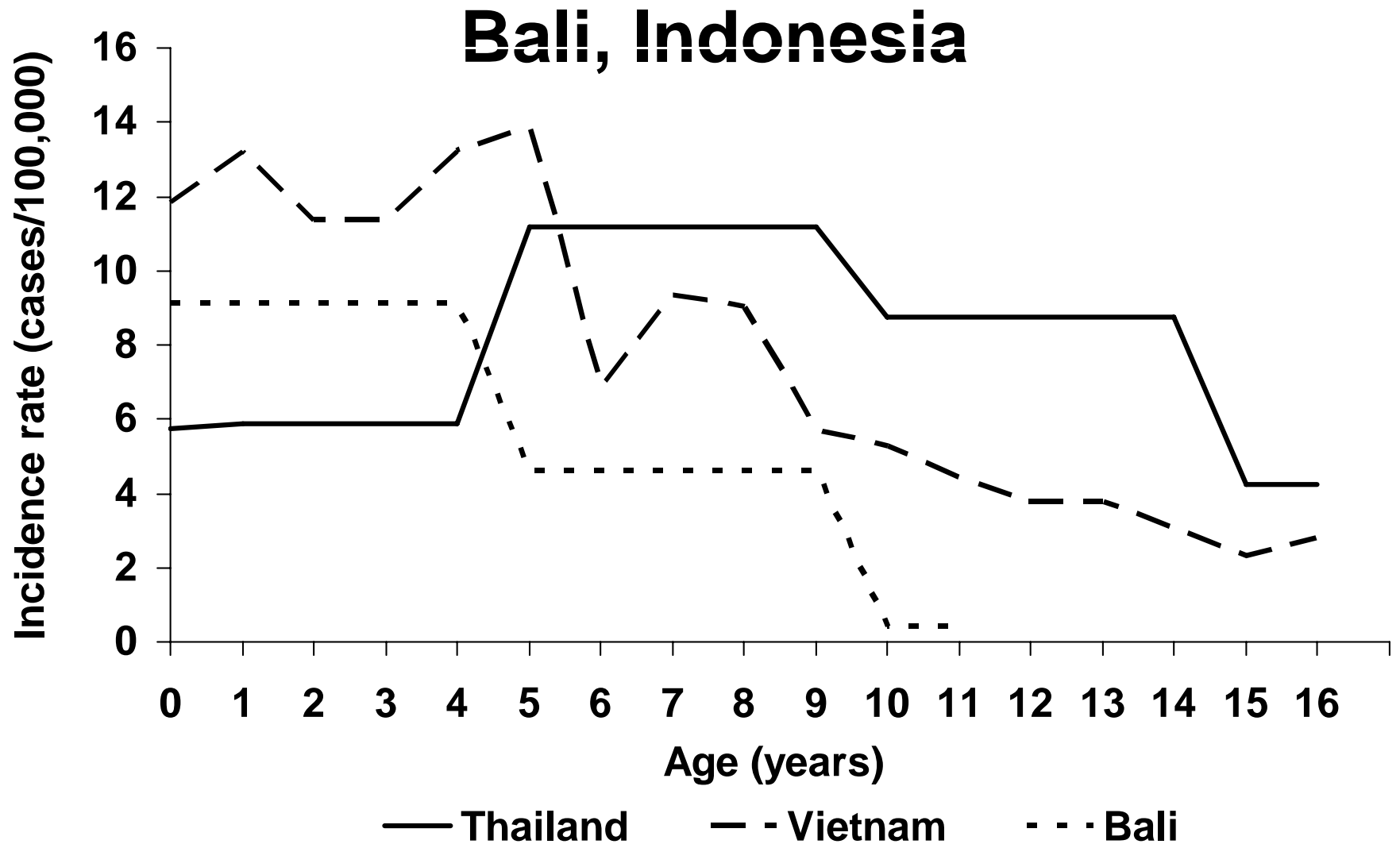
- Risk of JE in tropical Asia is similar to that in temperate and subtropical regions of Asia
- Rice fields providing breeding habitat for mosquito-vector (*Culex tritaeniorhynchus*) spread across all JE endemic areas.
- Pig is an amplifying host. JE risk is lower in Muslim areas than in non-Muslim areas where pig rearing is a common practice.
- JE risk is to be measured in more Muslim populations of Asia (Pakistan, Bangladesh Malaysia).
- JE vaccine should be introduced into tropical Asian countries that are endemic for JE.
- Philippines, Myanmar, Laos, Southern Thailand, Southern Vietnam, North Korea and many pacific islands that ecologically favorable (rice fields and pigpens) for JE transmission, reported low JE incidence rates probably due to insufficient JE surveillance.

# **Part II. Cost-effectiveness of JE immunization in Northern Thailand, Northern Vietnam and Bali, Indonesia**

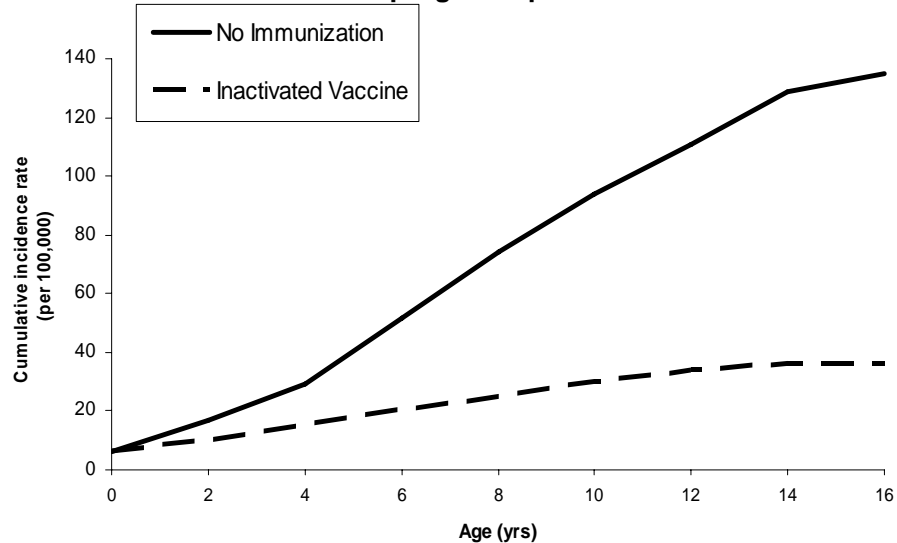
# Methods

A decision-analytical model was used to compare the costs and health outcomes for 2 hypothetical cohorts, one with and the other without JE immunization, each consists of 100,000 newborns, and followed from birth to 10-15 years. Cumulative JE incidence rate was calculated using the annual, average age-specific rates during pre-immunization period to represent the occurrence of JE in the non-immunized cohort.

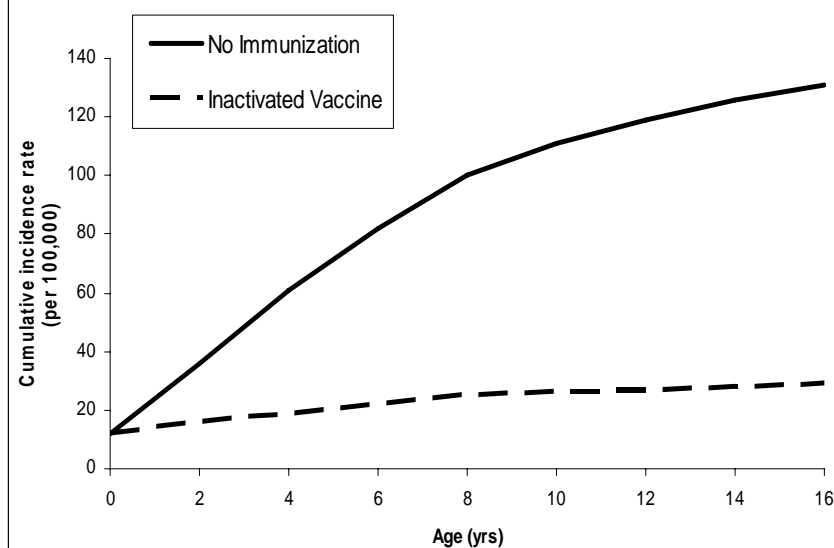
# Average, annual age-specific JE incidence rates in 8 high-risk provinces in Thailand, 16 high-risk districts in Vietnam, and in



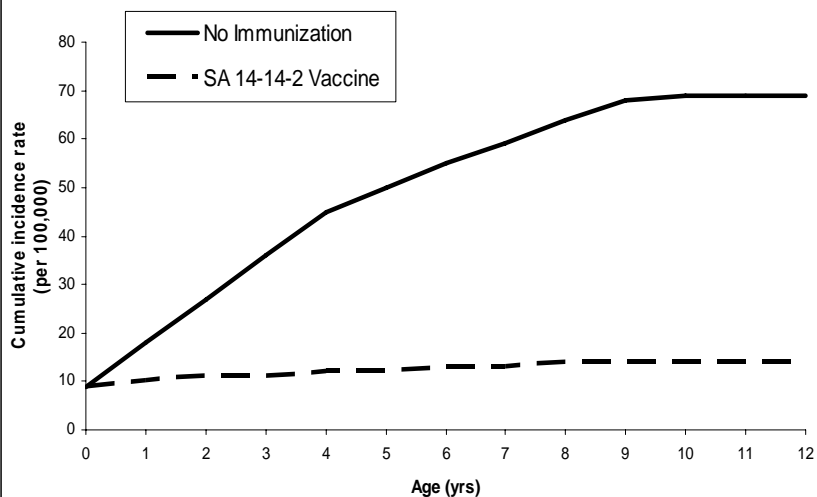
**Cumulative incidence rates of Japanese Encephalitis  
in 2 immunization program options in Thailand**



**Cumulative incidence rates of Japanese Encephalitis  
in 2 immunization program options in Vietnam**



**Cumulative incidence rates of Japanese Encephalitis  
in 2 immunization program options in Bali, Indonesia**





# Parameters for cost-effectiveness analysis of JE immunization program in Northern Thailand, Northern Vietnam and Bali

Variable	Thailand	Vietnam	Bali
Cost per dose of vaccine (\$)	2.52 (SMB)	0.23 (SMB)	1.0(sa-14-14-2)
Recurrent costs/ injection (\$)	0.69	0.15	0.2
Cost/case for acute care of JE illness (\$)	129.6	261	436
Cost/case for long-term care for disability following JE (\$)	1,013.2	1,008	1,813
Annual discount rate for costs (%)	3	3	3
GNP per capita (2002 US\$)	6,800	390	788

# Parameters for cost-effectiveness analysis of JE immunization program in Northern Thailand, Northern Vietnam and Bali

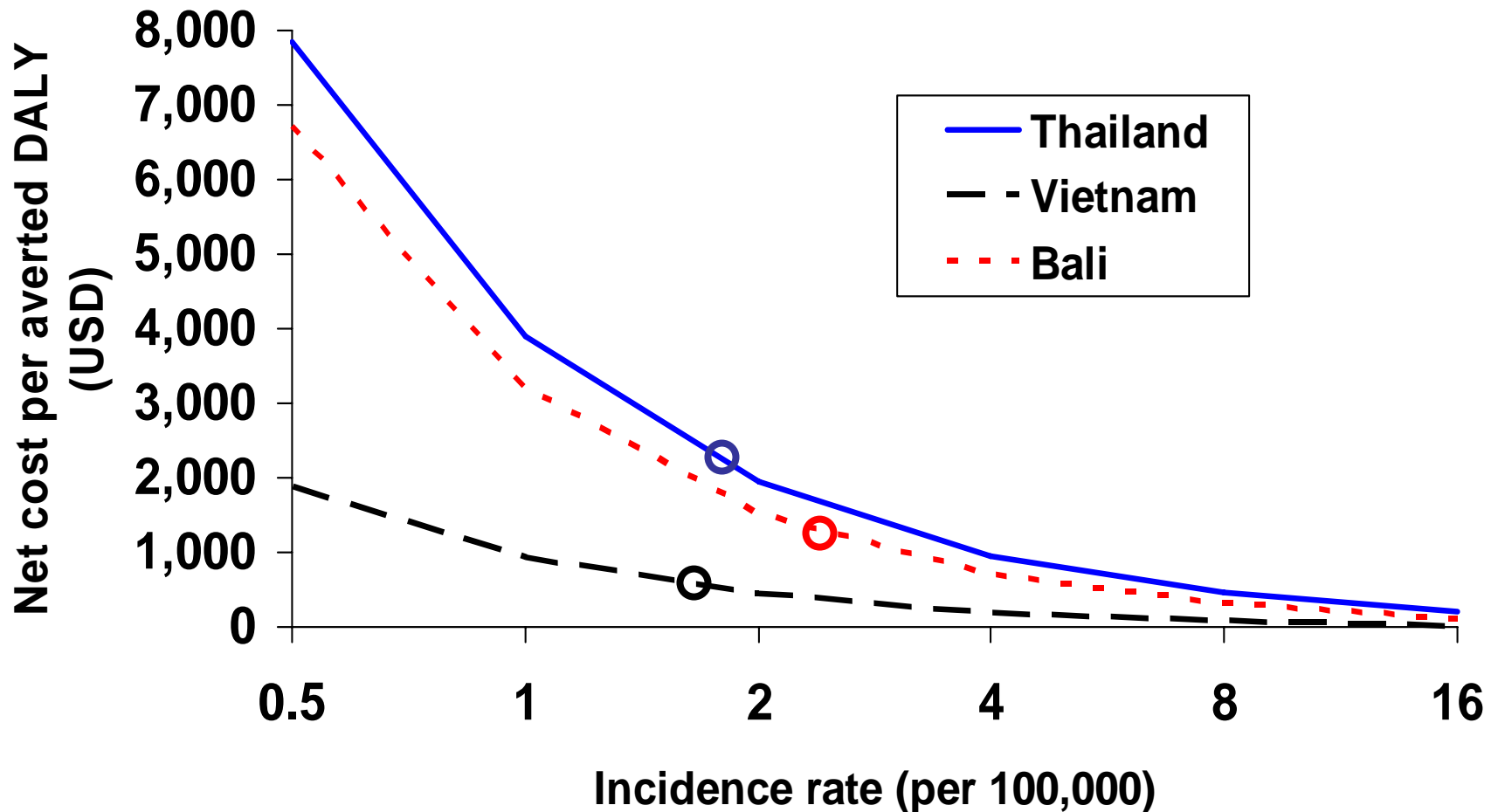
Variable	Thailand Mouse-brain inactivated	Vietnam Mouse-brain inactivated	Bali SA14-14-2 Live-atten'
Vaccine coverage			
Dose 1	84%	97%	90%
Dose 2	84%	96%	90%
Dose 3	76%	95%	
Vaccine efficacy			
Dose 1	50%	50%	95%
Dose 2	91%	91%	98%
Dose 3	94%	94%	

# Net cost per averted DALY against GNP per capita in Thailand, Vietnam and Indonesia

	Net cost per averted DALY (USD)	GNI per capita	%
Thailand	238	2,500	9.4
Vietnam	62	550	11.3
Bali	129	1,140	11.3

**\* Source of GNI per capita: ADB, 2006**  
**DALY: Disability-adjusted Life-Year**

# Net cost per averted DALY by JE incidence in Thailand, Vietnam and Bali



## Conclusions - Part II

- Routine childhood JE immunization with either inactivated, mouse brain vaccine or live, attenuated vaccine is highly cost-effective in Northern Thailand at JE incidence rate of 8.6/100,000, in Northern Vietnam at the rate of 8.2/100,000 and in Bali at the rate of 8.0/100,000.
- Costs of immunization per DALY averted accounted for only 9.4%, 11.3% and 11.3% of GNI per capita for the 3 sites respectively.
- JE immunization will keep cost-effective at annual JE incidence rate around 2 per 100,000 in the 3 countries.

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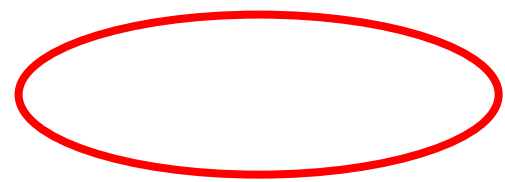
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